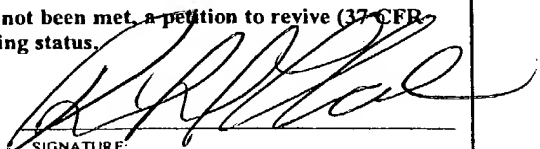


JC05 Rec'd PCT/PTO 11 MAY 2001

FORM PTO-1390 (REV 12-29-99)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 6056-000040	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (If known, see 37 CFR 1.5) <b>09/831698</b>	
INTERNATIONAL APPLICATION NO. PCT/DE99/03570		INTERNATIONAL FILING DATE November 9, 1999		PRIORITY DATE CLAIMED November 13, 1998	
TITLE OF INVENTION CO <sub>2</sub> Slab Laser					
APPLICANT(S) FOR DO/EO/US Norbert Taufenbach					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<p>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</p> <p>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))</p> <p>a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <input type="checkbox"/> has been transmitted by the International Bureau.</p> <p>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <p>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <input type="checkbox"/> have been transmitted by the International Bureau.</p> <p>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p>d. <input checked="" type="checkbox"/> have not been made and will not be made.</p> <p>8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p><b>Items 11. to 16. below concern document(s) or information included:</b></p> <p>11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13. <input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.</p> <p><input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</p> <p>14. <input type="checkbox"/> A substitute specification.</p> <p>15. <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>16. <input checked="" type="checkbox"/> Other items or information:</p> <p>Express Mail Transmittal</p> <p>Six sheets of formal drawings</p>					

US APPLICATION NO. (If known, enter 37 CFR 1.53) <b>09/831698</b>		INTERNATIONAL APPLICATION NO. PCT/DE99/03570		ATTORNEY'S DOCKET NUMBER 6056-000040	
17. <input type="checkbox"/> The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$970.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$840.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$670.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$96.00 <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<b>CALCULATIONS . PTO USE ONLY</b>          	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	- 20 =		X \$18.00	\$	
Independent claims	- 3 =		X \$78.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00	\$	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
<b>SUBTOTAL =</b>				\$	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				\$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
<b>TOTAL FEES ENCLOSED =</b>				\$	
				Amount to be:	\$
				refunded	\$
				charged	\$
a. <input type="checkbox"/> A check in the amount of \$_____ to cover the above fees is enclosed.  b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$_____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _____. A duplicate copy of this sheet is enclosed.					
<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>					
SEND ALL CORRESPONDENCE TO:  Richard L. Carlson Harness, Dickey & Pierce, P.L.C. P. O. Box 828 Bloomfield Hills, MI 48303					
				 SIGNATURE: Richard L. Carlson NAME 27863 REGISTRATION NUMBER	

09831698 09/831698

09/831698

JC08 Rec'd PCT/PTO 11 MAY 2007

PATENT

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Application No.:

Filing Date:

Applicant: Norbert Taufenbach

Group Art Unit:

Examiner:

Title: CO<sub>2</sub> Slab Laser

Attorney Docket: 6056-000040

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Hon. Commissioner of Patents and Trademarks  
Washington, D.C. 20231

**PRELIMINARY AMENDMENT**

Preliminary to the examination of this application on its merits, please enter the following amendments:

**IN THE CLAIMS:**

Please cancel Claims 4, 6, 7, 8, 10, 12 and 13 without prejudice.

Please amend the claims in accordance with the following rewritten claims in clean form. Applicant includes herewith an Attachment for Claim Amendments showing a marked up version of each amended claim in which underlines indicate insertions and brackets indicate deletions.



REMARKS

The above amendments are being presented to eliminate the multiple dependent claims as presented in this German language application. It is anticipated that some or all of these claims will be represented at the time an English language translation of this application is filed.

Respectfully submitted,

By: 

Richard L. Carlson  
Reg. No. 27863  
Attorney for Applicant

Harness, Dickey & Pierce, P.L.C.  
P. O. Box 828  
Bloomfield Hills, MI 48303  
(248) 641-1600

May 11, 2001  
RLC/jb

**ATTACHMENT FOR CLAIM AMENDMENTS**

The following is a marked up version of the amended claim in which underlines indicates insertions and brackets indicate deletions.

9. (Amended) CO<sub>2</sub>-Slablaser nach Anspruch [7] 1, dadurch gekennzeichnet, daß das Federlager ein Balg ist.



09/831,698  
29 Jan 2002

Attorney Docket 6056-000040

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Norbert Taufenbach

Serial No. 09/831,698

Filed: May 11, 2001

For: CO<sub>2</sub> SLAB LASER

Hon. Commissioner of Patents & Trademarks  
Washington, D.C. 20231

**SECOND PRELIMINARY AMENDMENT**

Sir:

Prior to the examination of this application, please amend it as follows:

**IN THE SPECIFICATION**

Please replace the following paragraphs of the specification. Applicant includes herewith an Attachment for Specification Amendments showing a marked up version of each replacement paragraph.

**Page 1, before the first paragraph**, please insert the following header:

**BACKGROUND AND SUMMARY OF THE INVENTION**

**Page 6, between lines 4 and 5**, please add the as following header:

**BRIEF DESCRIPTION OF THE DRAWINGS**

**Please replace the paragraph beginning on page 6, line 7** with the following paragraph in clean form:

Fig. 1 is a perspective view showing a laser according to the invention with cooling means at both ends;

**Please replace the paragraph beginning on page 6, line 9 with the following paragraph in clean form:**

Fig. 2 is a perspective view of the laser according to the invention with the cooling fins removed and portions thereof broken away, where the two electrodes with cooling medium channels, as well as the structure of the end pieces with flexible bearings, can be seen;

**Please replace the paragraph beginning on page 6, line 12 with the following paragraph in clean form:**

Fig. 3 is a perspective view of a flexible bearing end piece utilized in the laser of Figure 1;

**Please replace the paragraph beginning on page 6, line 13 with the following paragraph in clean form:**

Fig. 4 is a section view of the flexible bearing end piece of Fig. 3;

**Please replace the paragraph beginning on page 6, line 14 with the following paragraph in clean form:**

Fig. 5 is a longitudinal section view of the laser structure of Fig. 2 with the section being taken along a plane passing through the longitudinal axis thereof;



**Please replace the paragraph beginning on page 6, line 15 with the following paragraph in clean form:**

Fig. 6 is an exploded view of the laser structure of Figure 1 with a shielding netting surrounding the tubular housing all in accordance with the present invention; and

**Please replace the paragraph beginning on page 6, line 17 with the following paragraph in clean form:**

Fig. 7 is a perspective view of a laser structure with a tubular housing that in its center is provided with a flexible bellows all in accordance with the present invention.

**On page 6, between lines 18 and 19, please insert the following header:**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

**Please replace the paragraph beginning on page 7, line 12 with the following paragraph in clean form:**

This makes it possible, by means of the adjusting screws 20, to adjust the end pieces, which as shown in Fig. 2, each support one of the two electrodes fastened on the outer (movable) section 24, by means of the adjusting screws 20 in the angular position to the other electrode in each instance (in Fig. 2) to the electrode 36, which is fastened at the left end.

**IN THE CLAIMS**

Please amend the claims in accordance with the following rewritten claims in

clean form. Applicant includes herewith an Attachment for Claim Amendments showing a marked up version of each amended claim.

1. (Amended) A CO<sub>2</sub> slab laser having a gas-filled chamber defined by a tubular housing (10), with at least two electrodes that extend into the tubular housing, said electrodes overlapping one another and forming a discharge chamber, and resonator mirrors provided within said housing, characterized in that

said electrodes are each supported at the opposite ends of said tubular housing,

said mirrors are supported in stationary relationship relative to the electrodes and

said electrodes and mirrors are adjustable relative to one another.

---

2. (AMENDED) A CO<sub>2</sub> slab laser having a gas-filled chamber defined by a tubular housing, with at least two electrodes that extend into the tubular housing, said electrodes overlapping one another and forming a discharge chamber, and resonator mirrors provided within said housing, characterized in that

said electrodes are each supported at the opposite ends of said tubular housing,

said mirrors are designed in one piece with said electrodes and

said electrodes and mirrors are adjustable relative to one another.

3. (Amended) A CO<sub>2</sub> slab laser having a gas-filled chamber defined by a tubular housing (10), with at least two electrodes that extend into the

tubular housing, said electrodes overlapping one another and forming a discharge chamber, and resonator mirrors provided within said housing, characterized in that

said electrodes each are held at the opposite ends of said tubular housing,

said mirrors are supported in stationary relationship relative to said electrodes and

said electrodes and said mirrors are adjustable relative to one another.

5. (Amended) A CO<sub>2</sub> slab laser according to Claim 3, characterized in that the electrodes are designed in one piece with the end pieces.

9. (Amended) A CO<sub>2</sub> slab laser according to Claim 7, characterized in that the flexible bearing is a bellows.

11. (Amended) A CO<sub>2</sub> slab laser according to Claim 9, characterized in that the adjusting elements contain piezoelectric crystals which are capable of being driven electrically.

**Please add the following new claims:**

14. (Added) A CO<sub>2</sub> slab laser having a gas-filled chamber defined by a tubular housing as set forth in Claim 2, characterized in that the electrodes are held by the end pieces sealing off the tubular housing.



21. (Added) A CO<sub>2</sub> slab laser according to Claim 14, characterized in that the tubular housing (10) is designed in two parts, said two parts being interconnected and adjustable relative to one another.

22. (Added) A CO<sub>2</sub> slab laser according to Claim 15, characterized in that the tubular housing (10) is designed in two parts, said two parts being interconnected and adjustable relative to one another.

23. (Added) A CO<sub>2</sub> slab laser according to Claim 16, characterized in that the tubular housing (10) is designed in two parts, said two parts being interconnected and adjustable relative to one another.

24. (Added) A CO<sub>2</sub> slab laser according to Claim 3, characterized in that at least one of the end pieces defining said housing is attached to the tubular housing (10) by way of a flexible bearing.

25. (Added) A CO<sub>2</sub> slab laser according to Claim 4, characterized in that at least one of the end pieces defining said housing is attached to the tubular housing (10) by way of a flexible bearing.

26. (Added) A CO<sub>2</sub> slab laser according to Claim 5, characterized in that at least one of the end pieces defining said housing is attached to the tubular housing (10) by way of a flexible bearing.



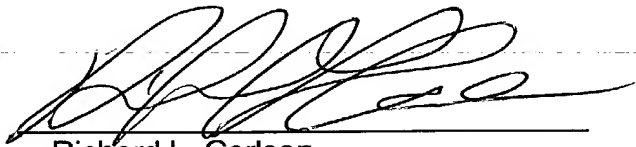
**REMARKS**

The Examiner is advised that the above amendments are being made with respect to the English language translation of the subject application and hence all references are with respect to the certified translation previously filed.

Claims 1-3, 5, 9, and 11 have each been amended to place them in better form for examination and claims 14 through 29 have been added by way of this amendment. Claims 14-29 correspond in modified form to previously cancelled claims 4, 6, 7, 8, 10, 12 and 13.

Favorable consideration and allowance of this application is respectfully requested.

Respectfully submitted,

By:   
 Richard L. Carlson  
 Reg. No. 27,863  
 Attorney for Applicant

Harness, Dickey & Pierce, P.L.C.  
 P.O. Box 828  
 Bloomfield Hills, MI 48303  
 (248) 641-1600

January 14, 2002  
 RLC/jb

**ATTACHMENT FOR SPECIFICATION AMENDMENTS**

The following is a marked up version of each replacement paragraph and/or section of the specification in which underlines indicates insertions and brackets indicate deletions.

**Page 1, before the first paragraph, please insert the following header:**

**BACKGROUND AND SUMMARY OF THE INVENTION**

**Page 6, between lines 4 and 5, please insert the following header::**

**BRIEF DESCRIPTION OF THE DRAWINGS**

**Please amend the paragraph beginning on page 6, line 7 as follows:**

Fig. 1 [shows the] is a perspective view showing a laser according to the invention with cooling means at both ends [in a perspective general view];

**Please amend the paragraph beginning on page 6, line 9 as follows:**

Fig. 2[,] is a perspective view of the laser according to the invention [for external cooling circuit in a partial sectional view] with the cooling fins removed and portions thereof broken away, where the two electrodes with cooling medium channels, as well as the structure of the end pieces with flexible bearings, can be seen;



[illegible]

**Please amend the paragraph beginning on page 6, line 12 as follows:**

Fig. 3[,] is a perspective view of a flexible bearing end piece [in a perspective view] utilized in the laser of Figure 1;

**Please amend the paragraph beginning on page 6, line 13 as follows:**

Fig. 4[.] is a section view of the flexible bearing [the] end piece of Fig. 3 [in a sectional view];

**Please amend the paragraph beginning on page 6, line 14 as follows:**

Fig. 5[,] is a longitudinal sectional view of the laser structure of Fig. 2 [in longitudinal section] with the section being taken along a plane passing through the longitudinal axis thereof;

**Please amend the paragraph beginning on page 6, line 15 as follows:**

Fig. 6[,] is an exploded view of the laser structure of Figure 1 with a shielding netting surrounding the tubular housing all in accordance with the present invention; and

**Please amend the paragraph beginning on page 6, line 17 as follows:**

Fig. 7[,] is a perspective view of a laser structure with a tubular housing that in its center is provided with a flexible bellows all in accordance with the present invention.



### **ATTACHMENT FOR CLAIM AMENDMENTS**

The following is a marked up version of each amended claim in which underlines indicates insertions and brackets indicate deletions.

1. (AMENDED) A CO<sub>2</sub> slab laser having a gas-filled chamber [limited] defined by a tubular housing (10), with at least two electrodes that extend into the tubular housing, said electrodes [overlap] overlapping one another and [form] forming a discharge chamber, and [with] resonator mirrors provided within said housing, characterized in that

[- the] said electrodes are each [held] supported at the opposite ends of [the] said tubular housing,

[- the] said mirrors are [arranged] supported in stationary relationship relative to the electrodes and

[- the] said electrodes[, jointly with the] and mirrors[,] are adjustable relative to one another.

2. (AMENDED) A CO<sub>2</sub> slab laser having a gas-filled chamber [limited] defined by a tubular housing, with at least two electrodes that extend into the tubular housing, said electrodes [overlap] overlapping one another and [form] forming a discharge chamber, and [with] resonator mirrors provided within said housing, characterized in that

[- the] said electrodes are each [held] supported at the opposite ends of [the] said tubular housing,

[- the] said mirrors are designed in one piece with [the] said electrodes and

[- the] said electrodes[, jointly with the] and mirrors[,] are adjustable relative to one another.

3. (Amended)      A CO<sub>2</sub> slab laser [according to Claim CO<sub>2</sub> slab laser] having a gas-filled chamber [limited] defined by a tubular housing (10), with at least two electrodes that extend into the tubular housing, said electrodes [overlap] overlapping one another and [form] forming a discharge chamber, and [with] resonator mirrors provided within said housing, characterized in that

[- the] said electrodes each are held at the opposite ends of [the] said tubular housing,

[- the] said mirrors are [arranged] supported in stationary relationship relative to [the] said electrodes and

[- the] said electrodes[, jointly with the] and said mirrors[,] are adjustable relative to one another.

5. (Amended)      A CO<sub>2</sub> slab laser according to Claim 3, characterized in that the electrodes are designed in one piece with the end pieces.

9. (Amended)      A CO<sub>2</sub> slab laser according to Claim 7, characterized in that the flexible bearing is a bellows.

11. (Amended)      A CO<sub>2</sub> slab laser according to Claim 9, characterized in that the adjusting elements contain piezoelectric crystals which are capable of being driven electrically.



09/831698  
Rec'd PCT/PTC 08 JAN 2002  
[Translation from German]

P.6579 PCT

### CO<sub>2</sub> Slab Laser

The invention relates to a CO<sub>2</sub> slab laser according to the generic clause of the main claim.

Slab lasers are disclosed in previous applications of, among others, the holder of this patent (e.g., WO 94/15384). Their geometry is characterized in that between two platelike electrodes, substantially parallel to one another, a narrow discharge chamber is formed for a gas, in particular CO<sub>2</sub>, which is excited by a high frequency voltage applied to the electrodes. For obtaining a laser effect, resonator mirrors are arranged on the opposite faces of the narrow discharge chamber formed by the electrodes.

As prior art there may be mentioned an article in a US periodical, N. Iehisa et al., "Performance characteristics of sealed-off CO<sub>2</sub> laser with La<sub>1-x</sub>Sr<sub>x</sub>CoO<sub>3</sub> oxide cathode," Journal of Appl. Phys 59 (1986), pages 317 to 323, in which a streamed gas laser with annular electrodes that [have] no cooling function as well as external mirrors provided outside of Brewster windows has already been described, where in one embodiment a partial reflector also is mounted on the outside on an end piece, so that the mirror, together with the electrodes, can be varied in its relative position.

To be mentioned in addition is US Patent 5,140,606, in which is shown, in a slab waveguide laser, an annular flexible bearing sealing off the laser chamber for adjusting at least one mirror separately from the electrodes.

Additional prior art is disclosed in European patent applications with publication numbers 0,275,023 A1, 0,305,893 B1 and 0,477,864 A1.

Common to all the abovementioned designs is that they have internally-cooled electrodes parallel to one another, which form between their plane surfaces turned toward one another a gas-filled chamber containing a gas to be pumped. Each of these electrodes has to be provided with a complicated fastening in the resonator chamber, especially since thermal deformation results in problems in making adjustment or readjustment, which substantially determines the laser output in an unstable resonator.

At the same time, care must be taken to see that the units to be adjusted are located in a closed chamber, through whose walls is passed as little as possible transmission, since these are very hard to seal off. In particular, seals of flexible materials cause problems, since they "gas out." But even when such seals are avoided, unavoidable sealing gaps result in critical sealing problems.

The object of the invention now is to procure a very small simple laser, wherein as few parts as possible are designed to result in low-cost manufacture. According to the invention, this is accomplished by a CO<sub>2</sub> slab laser having the features of the main claim. The dependent claims present advantageous embodiments of the invention.

This makes it possible to build a very tight metallic housing. A quartz housing has the same tightness advantages, since it can be soldered with metal.

It is particularly advantageous to obtain a gas-filled chamber having complete gas tightness that is limited by movable end pieces, designed as flexible bellows, for tilting about a small angle, and in which the electrodes lying opposite one another are borne by the respective end pieces [and] are arranged lengthwise to the tubular housing. At the same time, alignment of the mirrors, which are arranged on the electrodes or on the end pieces, in any case stationary relative to the electrodes and end pieces, may be effected by adjusting screws mounted on the end pieces outside the gas-filled chamber by way of the existing fixed connection of the electrodes with the end pieces (or by the one-piece design in one of the two elements, end piece or electrode). Leads through the wall of the gas-filled chamber need not be provided.

Adjusting elements, which are formed between two sections of the respective end piece, which due to having at least one groove - more advantageously two grooves arranged staggered, one from the inside and one from the outside - serve to position the sections of the end piece at an angle to one another in such a way that the outer (movable) section to which the respective electrode is fastened is adjustable in its angular position, since the thin wall thickness left between the grooves permits a small angular variation by elastic and/or plastic deformation of the material. The wall acts as a flexible bearing, similar to a bellows or an elastic membrane with small tilting motions of the outer annular surface relative to the inner annular surface.

It is proposed that the movable sections of the end pieces may be connected to one another by spring preloaded tension rods that are in connection with the respective other movable end piece, in order so to exert a constant restoring force on the movable end sections.

The gas-filled chamber is formed by a tubular housing, which assumes a variety of tasks. First of all, it is designed to serve to receive the laser gas mixture, but at the same time also to keep the sections to which the electrodes and hence, also the mirrors, are fastened at a constant distance apart. In addition, it isolates the two electrodes electrically from one another. Therefore, nonconducting materials, which advantageously should have little heat expansion, high gas tightness and high rigidity, are particularly suitable as material for the tubular housing. Quartz glass and aluminum oxide ceramic are proposed.

Shielding for the resultant electrical radiation is provided on the outside of the nonconducting tubular housing. Advantageously, this at the same time serves as inductance for the electrodes. Such shielding may be designed as wire mesh, metal bellows or metal foil. Separate shielding is not necessary in a metal housing, nor when only the surface is metallized. Then, to obtain suitable inductance of the tubular housing, in order to stabilize the discharge excited in the inside under HF conditions, the internal geometry, in particular the volume of the envelope, may be adapted to the inductance.

Since the mirrors of a laser according to the invention have no internal cooling and possess no special possibility of adjustment to the electrode, since mirror and electrode form a unit (either made in one piece or bolted firmly together), the heat that is produced in the mirrors is passed on to the electrode. Now, for these electrodes to have as little



thermal deformation as possible, they are designed with a semicircular cross section and are cooled internally by cooling bores. These cooling bores contain a cooling medium delivered by a cooling medium pump or advantageously a medium or vapor, which by free convection flow and/or by capillary action, as well as by phase transitions on the walls of the hollow chambers or capillaries, carry heat or latent heat away from the inner walls of the cooling bore.

Advantageously, at the end pieces of the tubular housing, outside the gas chamber, there are provided air coolers, to whose cooling ribs run the cooling lines formed by the cooling bores of the electrodes. For the purpose of better heat emission, flow against these cooling ribs may be provided from the outside by blowers. Efforts are made to use natural circulation according to the "heat pipe" principle. Heat pipes are hermetically sealed and evacuated hollow cylinders whose interior may contain any desired medium, e.g., water, which, at a conventional selected negative pressure, boils at low temperatures.

For example, under these negative pressure conditions water takes up only a small part of the free space, the rest being occupied by water vapor. There the water and water vapor serve for transfer of heat from a heated region of the tube to a cooled one (colder region), in other words, absorption or emission of heat by the water takes place not so much on the basis of heat capacity, but predominantly by latent heat in phase transition. Thus, quantities of heat are transported at very small temperature differences. The principle of the heat pipe was discovered back in 1942 and is used mostly in space technology.

According to the invention, in this way bulky cooling systems are avoided and a smaller and simpler laser is made possible, in which (provided with air coolers at both ends) only HF energy need be supplied from a HF line in order to obtain laser light. No additional cooling agent lines or power supplies are necessary.

The ensured gas tightness results in maximum gas service life, since no impurities penetrate from outside. Thus, the availability of the laser is limited over time only by the decomposition of gas, as well as by gas contamination due to the sputter effect in the gas discharge.

Additional features and advantages of the invention follow from the following description of a preferred example of the invention, wherein

Fig. 1 shows the laser according to the invention with cooling means at both ends in a perspective general view;

Fig. 2, the laser according to the invention for external cooling circuit in a partial sectional view, where the two electrodes with cooling medium channels, as well as the structure of the end pieces with flexible bearings, can be seen;

Fig. 3, a flexible bearing end piece in a perspective view;

Fig. 4, the end piece of Fig. 3 in a sectional view;

Fig. 5, the laser structure of Fig. 2 in longitudinal section;

Fig. 6, an exploded view of the laser structure with a shielding netting surrounding

the tubular housing and

Fig. 7, a laser structure with a tubular housing that in its center is provided with a flexible bellows.

The laser according to the invention, which is represented in Fig. 1, consists of a tubular housing 10, about which is stretched a shielding netting 12, in the event that a nonconducting material is used as shielding material. Metallization of the outer surface is alternatively possible. At the two ends are located end pieces 14, through which the electrodes 34, 36 are passed and on which air coolers 16 advantageously are mounted. A HF line, whose connection 18 can be seen in the right-hand side of the figure, is passed through one end piece with its air cooler. The laser light energy will exit through the other end piece with air cooler.

Adjusting screws 20 are provided on each of the end pieces, and under the shielding netting 12 the movable sections of the end pieces are connected together by tension rods 22. The tension rods 22 act upon the end pieces 14 in such a way that they in each instance pull together the movable sections 24, which are separated by grooves 28 from the fixed sections 26. So that the end pieces 24 still have mobility, spring assemblies 30 are provided under nuts 32 on the backs of the sections 24 pointing away from one another.

This makes it possible, by means of the adjusting screws 20, to adjust the end pieces, which as shown in Fig. 2, each bear one of the two electrodes fastened on the outer (movable) section 24, by means of the adjusting screws 20 in the angular position to

the other electrode in each instance (in Fig. 2) to the electrode 36, which is fastened at the left end.

In addition, one of the mirrors, namely the mirror 38, which is fastened to the lower electrode 34 by a bolt, is represented in Fig. 2. It can further be seen that three adjusting screws 20 and three tension rods 22 are proposed in order to obtain optimal adjustability. There the tubular housing 10 is designed cylindrical, while the electrodes 34, 36 in section form a circular segment whose radius is smaller than the inside radius of the tubular housing. The laser gas chamber thus is optimally utilized.

The cooling channels 40 within the electrodes, as well as the semicircular cross section of the electrodes 34, 36, may likewise be seen. The cooling medium bores 40 are connected either to air coolers 16 or to externally connected supplies and returns 42, 44, which lead to conventional external cooling circuits.

So that a crosspiece with a thin wall thickness is obtained, the grooves 28 according to the invention advantageously are supplemented by a groove 48 on the inside, as may be seen in Figs. 3 and 4. The foot 50 of the electrode, enlarged in diameter, is then fitted into a narrow recess 46 on the outer side of the end pieces.

In Fig. 5, as in Fig. 2, the arrangement is again shown in longitudinal section. Here it can be seen that the mirrors 38, fastened on the electrodes in each instance, are opposite one another in the gas chamber. As already described in detail in the aforementioned printed sources of the prior art, HF energy is applied to the electrodes electrically isolated from one another, so that a gas discharge takes place between the

electrodes, while for output the output mirror is designed shorter than the return mirror, so that part of the laser light energy is emitted. There the number of reflections and hence optimal utilization of the reflection is strongly dependent upon the correct adjustment.

This adjustment can be obtained with the adjusting screws 20 by varying the position of the outer sections of the end pieces 24 relative to the inner sections of the end pieces 26. It is alternatively possible to arrange piezoelectric crystals in the adjusting screws, in order to finely adjust the resonator or, if necessary, readjust it in operation. Such piezoelectric crystals may alternatively be provided in the electrodes themselves, in order to counteract the thermal deformation of the electrodes depending on laser light output.

In the right-hand section of the drawing, it can clearly be seen that these are one-piece end pieces. A soldered or welded general structure is preferable, wherein the two sections 24, 26 of the end pieces 14 (as well as the housing surrounding the gas-filled chamber with the sections 26 and the electrodes 34, 36 in each instance with the section 24) are connected together gas-tight. Cementing together or sealing by sealing rings would not provide such good gas tightness.

At the same time, adjustability of the electrodes with the mirrors may alternatively be provided only at the time of assembly, and later be fixed after adjustment by welding, soldering or cementing of the mounting. In this case, it is not necessary to attach the adjusting elements to the laser or to leave them on it.

Lastly, with reversal of the ends on the right and left, an exploded view of the

Fig. 7 shows the CO<sub>2</sub> slab laser in an additional embodiment, in which the tubular housing 10 is designed in two parts, connected in the center by flexible bellows 54, where the two parts are designed adjustable relative to one another.

CLAIMS

1. CO<sub>2</sub> slab laser having a gas-filled chamber limited by a tubular housing (10), with at least two electrodes that extend into the tubular housing, overlap one another and form a discharge chamber, and with resonator mirrors, characterized in that

- the electrodes are each held at the opposite ends of the tubular housing,
- the mirrors are arranged stationary relative to the electrodes and
- the electrodes, jointly with the mirrors, are adjustable relative to one another.

2. CO<sub>2</sub> slab laser having a gas-filled chamber limited by a tubular housing, with at least two electrodes that extend into the tubular housing, overlap one another and form a discharge chamber, and with resonator mirrors, characterized in that

- the electrodes are each held at the opposite ends of the tubular housing,
- the mirrors are designed in one piece with the electrodes and
- the electrodes, jointly with the mirrors, are adjustable relative to one another.

3. CO<sub>2</sub> slab laser according to Claim CO<sub>2</sub> slab laser having a gas-filled chamber limited by a tubular housing (10), with at least two electrodes that extend into the tubular housing, overlap one another and form a discharge chamber, and with resonator mirrors,

characterized in that

- the electrodes each are held at the opposite ends of the tubular housing,
- the mirrors are arranged stationary relative to the electrodes and
- the electrodes, jointly with the mirrors, are adjustable relative to one another.

4. CO<sub>2</sub> slab laser having a gas-filled chamber limited by a tubular housing, or [Claim?] 2, characterized in that the electrodes are held by the end pieces sealing off the tubular housing.

5. CO<sub>2</sub> slab laser according to Claim 3, characterized in that the electrodes are designed in one piece with the end pieces.

6. CO<sub>2</sub> slab laser according to Claim 3 or 4, characterized in that the mirrors are designed in one piece with the end pieces.

7. CO<sub>2</sub> slab laser according to any one of the preceding claims, characterized in that the tubular housing (10) is designed in two parts, where the two parts are designed adjustable relative to one another.

8. CO<sub>2</sub> slab laser according to Claim 3, 4 or 5, characterized in that at least one of the end pieces is attached to the tubular housing (10) by way of a flexible bearing.



9. CO<sub>2</sub> slab laser according to Claim 7, characterized in that the flexible bearing is a bellows.

10. CO<sub>2</sub> slab laser according to any one of the preceding claims, characterized by adjusting elements (20) that are supported on the tubular housing and act on the electrodes.

11. CO<sub>2</sub> slab laser according to Claim 9, characterized in that the adjusting elements contain piezoelectric crystals which are capable of being driven electrically.

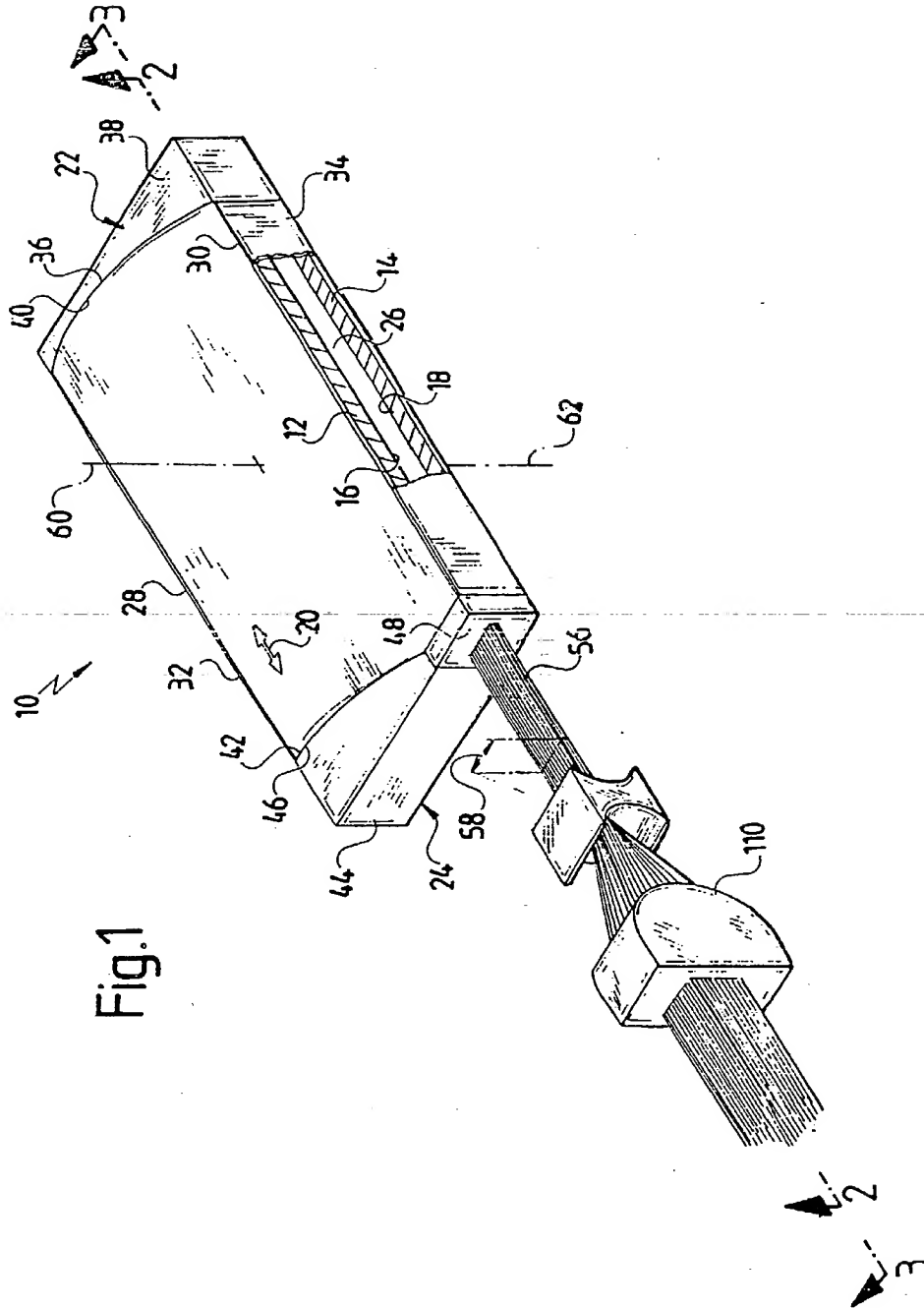
12. CO<sub>2</sub> slab laser according to any one of the preceding claims, characterized in that the tubular housing (10) is designed cylindrical and the electrodes in section form a circular segment whose radius is smaller than the inside radius of the tubular housing.

13. CO<sub>2</sub> slab laser according to any one of the preceding claims, characterized in that the electrodes and hence the mirrors are fixed relative to one another after adjustment.

## Abstract

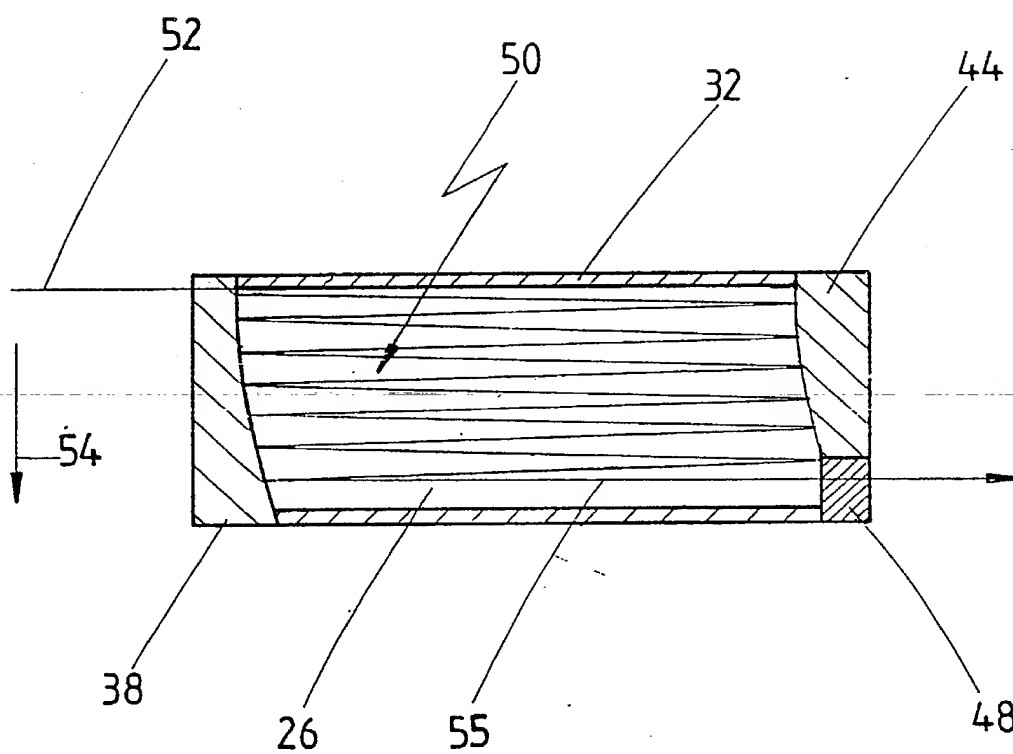
### CO<sub>2</sub> Slab Laser

CO<sub>2</sub> slab laser having a gas-filled tubular housing, sealed off at both ends by end pieces, which accommodates two overlapping electrodes extending into the tubular housing and mirrors arranged in the region of the electrodes, where each of the two end pieces holds an electrode (34, 36), the mirrors are arranged stationary relative to the electrodes and the electrodes, jointly with the mirrors, are adjustable relative to one another.



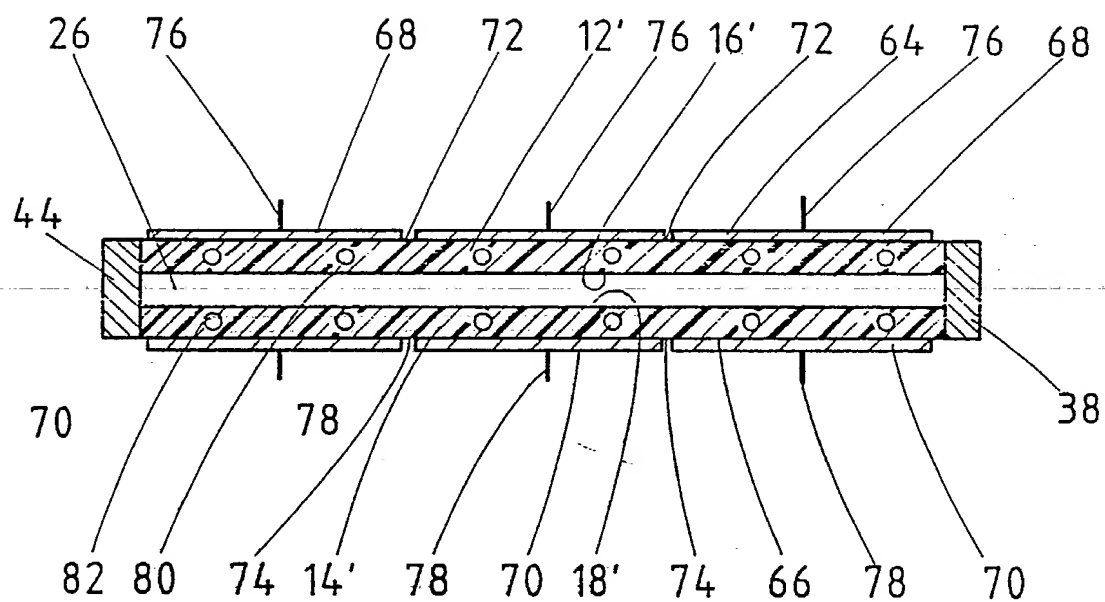
EP 0 305 893 A2

Fig. 2



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Fig. 3



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Fig. 4

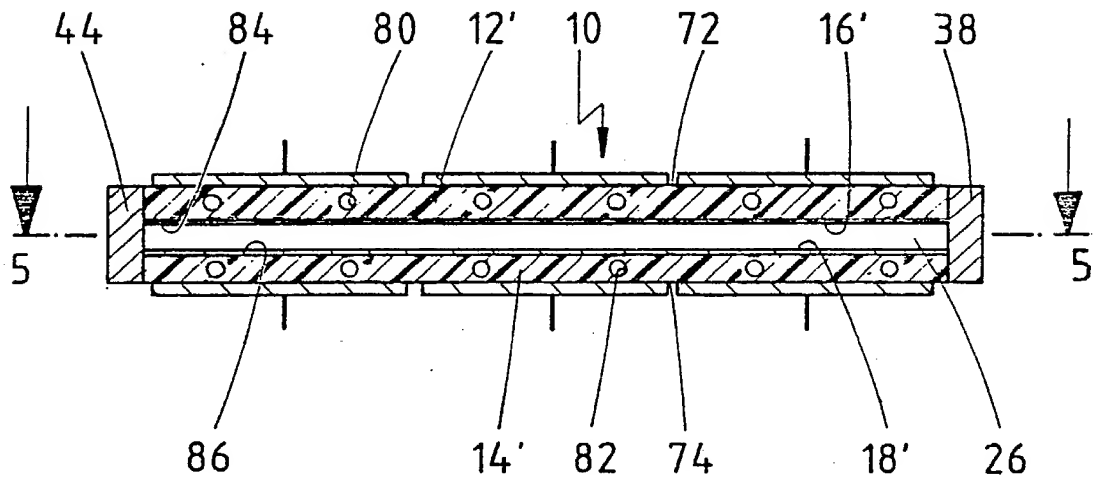
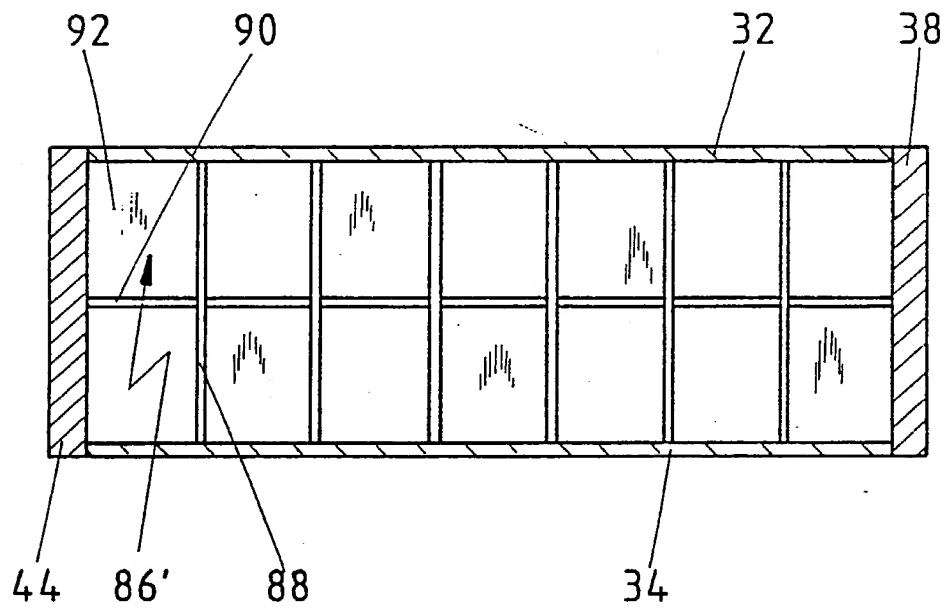
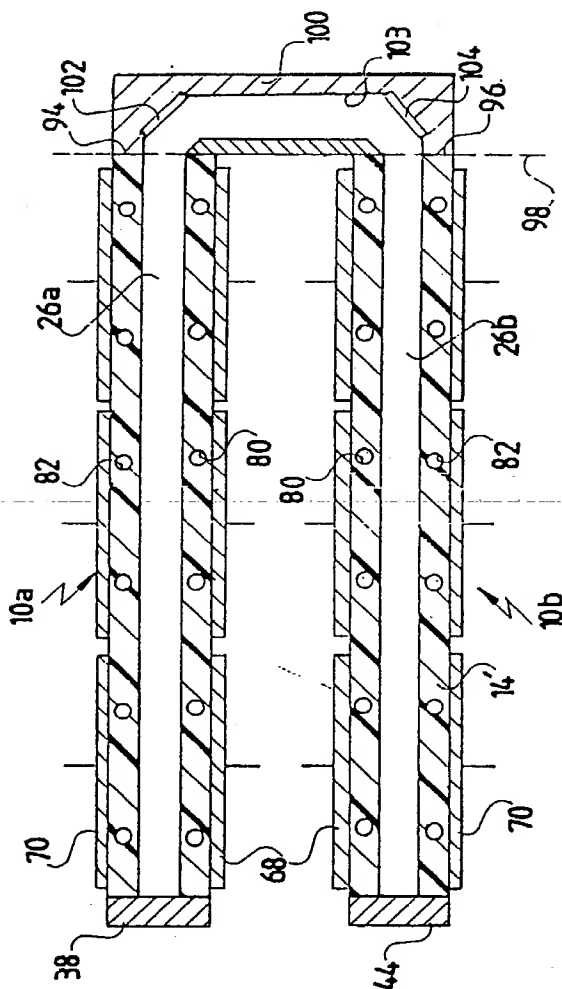


Fig. 5



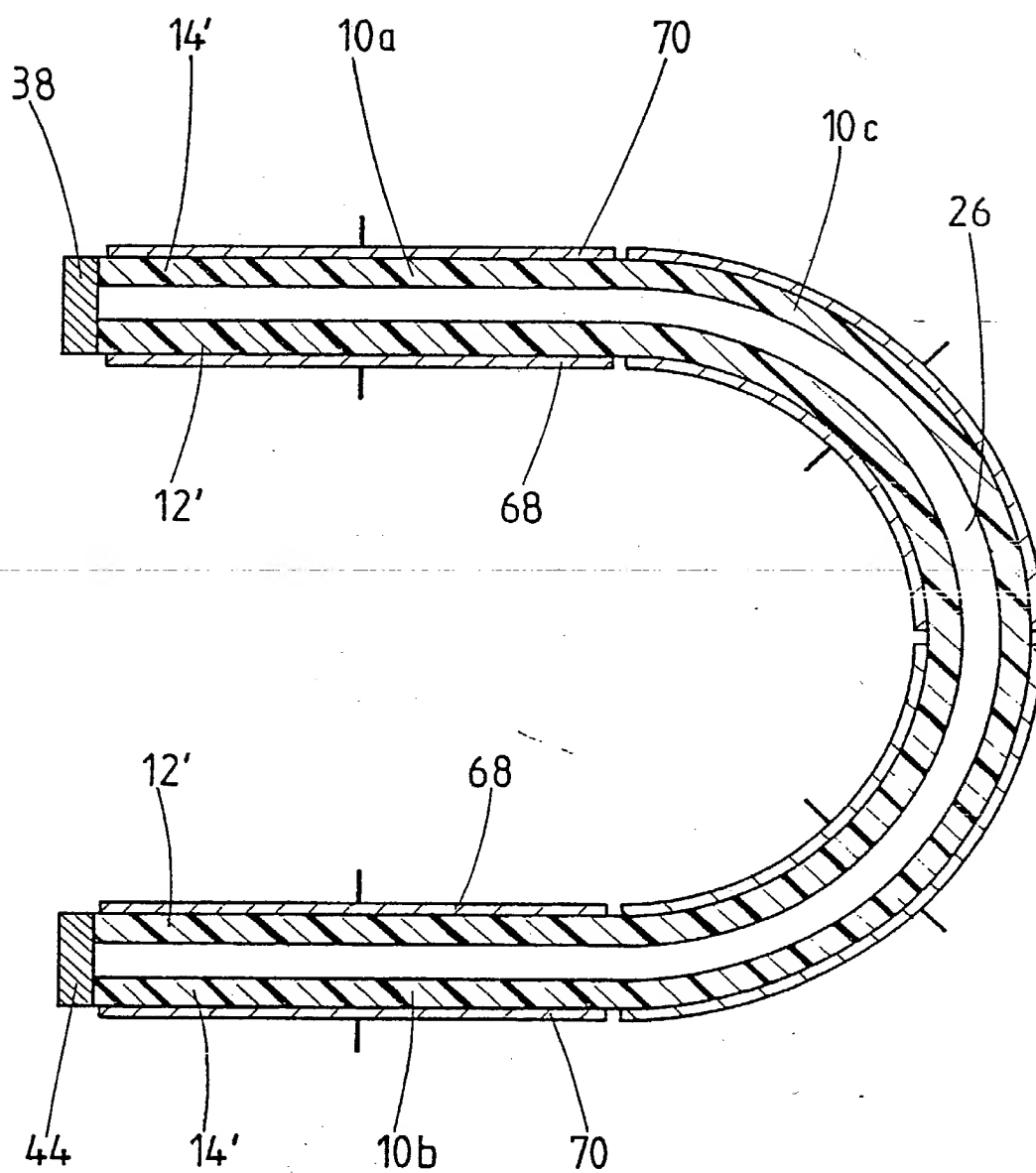
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Fig.6



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Fig. 7





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## AFFIDAVIT OF ACCURACY

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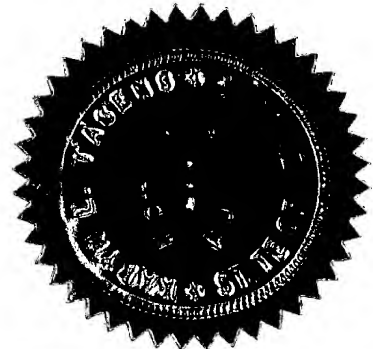
*Hela Hanchis*

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Subscribed and sworn to before me

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Qualified in New York County  
Commission Expires Oct. 31, 2002



# Declaration and Power of Attorney for Patent Application Erklärung für Patentanmeldungen mit Vollmacht

## German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

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CO<sub>2</sub> Slab Laser

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☒ wurde angemeldet am May 11, 2001  
unter der US-Anmeldenummer oder unter der  
Internationalen Anmeldenummer im Rahmen des  
Vertrags über die Zusammenarbeit auf dem Gebiet  
des Patentwesens (PCT)  
09/831,698 und am  
May 11, 2001 via Preliminary Amendment  
filed with application abgeändert (falls  
zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

CO<sub>2</sub> Slab Laser

the specification of which is attached hereto unless the following box is checked:

☒ was filed on May 11, 2001  
as United States Application Number or PCT  
International Application Number  
09/831,698 and was amended on  
May 11, 2001 via Preliminary Amendment filed with application  
(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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Prior Foreign Applications  
(Frühere ausländische Anmeldungen)

198 52 284.3                      Germany  
(Number)                      (Country)  
(Nummer)                      (Land)

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Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

(Application No.)                      (Filing Date)  
(Aktenzeichen)                      (Anmeldetag)

(Application No.)                      (Filing Date)  
(Aktenzeichen)                      (Anmeldetag)

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PCT/DE99/03570                      November 9, 1999  
(Application No.)                      (Filing Date)  
(Aktenzeichen)                      (Anmeldetag)

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Priority Not Claimed  
Priorität nicht beansprucht

13 November 1998  
(Day/Month/Year Filed)  
(Tag/Monat/Jahr der Anmeldung)

(Day/Month/Year Filed)  
(Tag/Monat/Jahr der Anmeldung)

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Published  
(Status) (patented, pending, abandoned)  
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## German Language Declaration

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Richard L. Carlson, Reg. No. 27863

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

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Vor- und Zuname des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any
Unterschrift des zweiten Erfinders Datum	Second Inventor's signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
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